



DEVELOPMENT OF COMPREHENSIVE MONITORING TECHNIQUES TO VERIFY THE INTEGRITY OF GEOLOGICALLY SEQUESTERED CARBON DIOXIDE

Background

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One of the most critical research areas is aimed at monitoring the long-term storage stability and integrity of CO₂ in geologic formations. Research aimed at monitoring the integrity of CO₂ sequestered in geologic formations is certainly one of the most pressing areas of need if geologic sequestration is to become a significant factor in meeting this country's stated objectives to reduce greenhouse gas emissions. The most promising geologic formations currently under consideration for CO₂ sequestration are active and depleted oil and gas formations, brine formations, and deep, unmineable coal seams. Unfortunately, the long-term CO₂ storage capabilities of these formations are not well explored.

Primary Project Goal

The goal of this effort is to develop and demonstrate advanced monitoring techniques to assess the capacity, stability, rate of leakage, and permanence of CO₂ storage in geologic formations.



Perfluorocarbon tracers in a syringe pump in the back of an NETL van are added to CO₂ as it is injected underground at the Frio saline aquifer sequestration test site near Houston, TX.



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Objectives

The primary objective of the project is to apply a complementary suite of surface and near-surface monitoring techniques to the detection of short-term, rapid loss and long-term, intermittent slow leakage of carbon dioxide (CO₂) from geologic storage formations. These techniques include monitoring perfluorocarbon tracers added to the injected CO₂ and detected in soil-gas at parts-per-quadrillion levels, shallow water aquifer chemistry changes, flux of CO₂ at the surface, and natural tracers (e.g., radon and methane) in soil-gas.

Additional objectives are to:

- Perform geophysical site analysis using ground-based measurements and remote sensing that combines satellite-visible and infrared views with optical aerial photography.
- Monitor for long- and short-term leakage at field projects, such as depleted oil wells, saline aquifers, and coal-bed methane recovery projects, in cooperation with Phase II projects of the Regional Sequestration Partnerships.
- Locate abandoned wells using airborne and ground-based magnetometry while simultaneously evaluating the leakage potential using radiometry and methanometry.
- Evaluate the degradation of well sealing cements under downhole conditions of temperature and pressure.

Accomplishments

The use of perfluorocarbon tracers was successfully completed at the West Pearl Queen depleted oil well sequestration test site in southeastern New Mexico. Extremely low levels of leakage were found to be associated with thinning and faulting in the caliche layer that underlies the sandy soil as evaluated using ground-penetrating radar. Similar levels of leakage were monitored at the Frio saline aquifer sequestration test site near Houston, TX, using the entire suite of monitoring techniques. Excellent agreement was found between monitoring methods.

To date, surface and near-surface monitoring have been successfully applied in the semiarid soil conditions of southeast New Mexico and at the heavily forested, swampy site near Houston, TX. Both airborne and ground-based magnetometry have proven effective at locating abandoned wells at enhanced oil recovery sites, including those deeply buried. High-pressure and temperature tests of brine and CO₂ on well sealing cements are being conducted using specialized reactor equipment including an yttrium-stabilized zirconia pH probe.

Benefits

Development of techniques to monitor the integrity of geologically sequestered CO₂ is needed to assure public health and safety and to gain public acceptance of geologic sequestration technology. Active and depleted oil and gas formations, brine formations, and deep coal seams that were previously unused now have the potential to serve as sinks for carbon dioxide sequestration. Additionally, by capturing carbon dioxide and sequestering it, harmful emissions into the atmosphere are prevented that may further increase global warming.